Section 10
Extravehicular Activity Overview

10.1 Introduction

Building the International Space Station (ISS) requires an enormous international effort and many long hours of preparation. The two major groups responsible for building and maintaining the Space Station are Extravehicular Activity (EVA) and Robotics. There are over 600 tasks that must be successfully completed for the assembly of the ISS. It is estimated that this requires approximately 540 hours of EVA to accomplish (this estimate does not include predictions for EVAs on Russian hardware or any maintenance predictions). Many long hours of preparation, training, and teamwork are necessary to make the assembly of the ISS a successful endeavor.

10.1.1 People Involved in EVA

For planning purposes, it is helpful to identify crewmembers as either shuttle crewmembers or Station crewmembers. A shuttle crewmember becomes a Station crewmember when his or her equipment is transferred to the Station. However, for EVA, an Extravehicular (EV) crewmember is not considered a Station EV crewmember until 7A, when the Joint Airlock arrives. After the Joint Airlock arrives, there could be orbiter-based EV crewmembers and Station-based EV crewmembers. As a general rule, crewmembers in Extravehicular Mobility Units (EMUs), regardless of their nationality, work on U.S. segments of the Station and crewmembers in the Orlan spacesuits, regardless of their nationality, work on Russian segments.

10.1.2 Types of EVAs

In the shuttle program there are three basic types of EVAs: scheduled, unscheduled, and contingency. A scheduled EVA is defined as any EVA that is incorporated into the nominal flight plan. Unscheduled EVAs are performed to achieve or enhance mission objectives and are not incorporated in the nominal flight plan. Contingency EVAs are performed in emergency situations to ensure the safety of the crew and the Orbiter. ***For Station, there are only two types of EVAs: nominal and contingency***. The reason for this is that on Station an unexpected EVA can always be worked into the nominal flight plan. Table 10-1 references the EVA Flight Rules definitions for scheduled, nominal, unscheduled and contingency EVAs.

Table 10-1. EVA flight rules

Flight Rules	Scheduled EVA	Nominal EVA	Unscheduled EVA	Contingency EVA
Shuttle	A15.1.1-4	NA	A15.1.1-5	A15.1.1-6
Station	NA	B15.2.1-4	NA	B15.2.1-5

10.2 Objectives

The overall goal of this section is to provide the student with a greater understanding of the role of EVA with respect to Space Station assembly and the equipment associated with EVA operations (such as spacesuits, the Joint Airlock, and various tools/restraints).

After completing this section, you should be able to

- Describe the major differences between the EMU and the Orlan spacesuits
- Identify the two major types of EVAs required for assembly of the Space Station
- Name the two major components that make up the Joint Airlock and describe the function of each component
- List the crewmember restraints and EVA tools available for the Space Station

10.3 Comparison of Spacesuits

The Joint Airlock has the capability of supporting EVAs with EMUs and Orlans. Although Orlan training does not occur in the U.S. (it occurs in Russia), it is useful to understand the major differences between the EMU and the Orlan spacesuits.

10.3.1 Extravehicular Mobility Unit

As illustrated in Figure 10-1, that the EMU is a modular suit made up of several parts which must be assembled for donning. The backpack on the back of the suit is called the Primary Life Support System (PLSS). It contains the necessary equipment and consumables to maintain crewmember life support. The PLSS and its components are exposed to vacuum, while the rest of the suit is nominally pressurized to 4.3 pounds per square inch differential (psid). EMU-based EVAs are nominally planned for 7 hours, including 15 minutes to egress the airlock, 6 hours of useful tasks, 15 minutes to ingress the airlock, and 30 minutes of reserved unplanned time. In addition, the EMU is equipped with a 30-minute supply of emergency oxygen located in the Secondary Oxygen Pack (SOP) at the bottom of the PLSS. Attached to the crewmember's wrist is a cuff checklist, which includes a status list for the EMU's Life Support System, and various off-nominal procedures. For additional safety, the EMU is equipped with Simplified Aid for EVA Rescue (SAFER) that allows the crewmember to pilot himself to safety, in the event that he becomes untethered and completely detached from the Space Station.

Figure 10-1. Extravehicular mobility unit

10.3.2 The Orlan-M

The Orlan-M, shown in Figure 10-2, is one adjustable size, requiring little assembly for donning. The Life Support System, mounted on the back of the suit, swings open like a door to allow crewmember access and entry into the suit. Unlike the EMU, the life support system is contained within the pressurized volume (5.7 psid) of the suit. Orlan-based EVAs are nominally planned for 5 hours. There is also a 30-minute supply of emergency O_2 located in the backup O_2 bottle. In contrast to the EMU's Cuff Checklist, Russian EV crewmembers typically do not bring out any procedures with them for EVAs; they rely almost solely on their memory from training. Like the EMU, the Orlan is also equipped with a version of SAFER that has been modified to fit the Orlan.

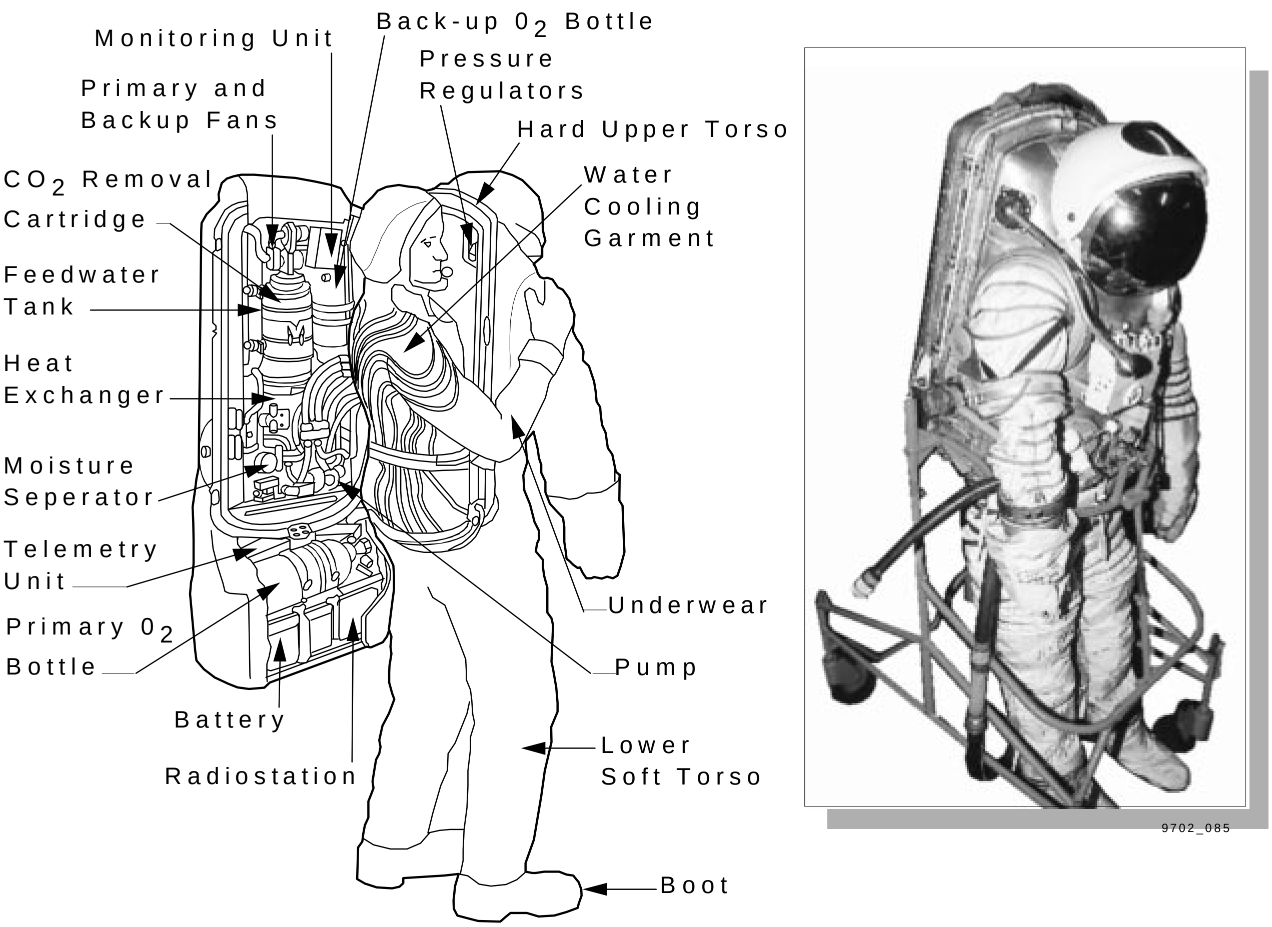

Figure 10-2. Orlan-M

10.3.3 EMU vs. Orlan

The EMU and Orlan spacesuits can be considered miniature spacecrafts. The suits contain all life support for a crewmember, including oxygen, pressure, cooling, filters for contaminants, power, and communication. While both suits were designed to allow crewmembers to work in the harsh vacuum of space, they have many differences which are outlined in Table 10-2.

Table 10-2. EMU and Orlan-M comparison

Suit feature	EMU	ORLAN-M
Sizing	Modular: The EMU is comprised of several interchangeable parts which are sized to fit the 5^{th} percentile female to the 95^{th} percentile male. Sizing rings in the arms and legs allow for resizing on orbit. Over 100 measurements are taken to ensure a proper fit in the gloves, upper torso, arms, lower torso, and boots	One adjustable size: The Orlan is compatible for crewmembers whose height falls between 5 feet 7 inches and 6 feet 2 inches. The Orlan's size is adjustable on orbit using Velcro straps to cinch up excess lengths
Entry Method	Waist entry: The crewmember puts on the EMU like clothes. There are various parts of the suit to assemble for donning. Self donning is possible, but usually an Intravehicular (IV) crewmember assists	Rear entry: The Orlan has a back door which swings open to allow the crewmember to step inside the suit. Self-donning is typical
Pressure	4.3 psid nominal	5.7 psid nominal
In-suit Prebreathe An in-suit prebreathe with 100% O_2 is required to allow the body to get rid of any nitrogen left in the blood stream which could cause decompression sickness (also known as "the bends")	If the cabin has been at 10.2 psi for at least 36 hours, a 40-minute in-suit prebreathe is required. If the cabin has been at 14.7 psi, a 4-hour in-suit prebreathe is required	30-minute nominal prebreathe (One reason for the shorter nominal prebreathe is the Orlan is pressurized to 5.7 psid. Also, the Russian Space Program accepts a higher level of nitrogen in the blood stream. Note that neither NASA nor the Russian Space Program has ever reported a case of the bends in space.)
On orbit useful life	From the time the EMU leaves processing (Boeing), the useful life of the EMU is 180 days or 25 EVAs. At the end of its useful life, the EMU is serviced and recertified for flight	The Orlan's useful life is 4 yrs or 10 EVAs. At the end of its useful life it' is placed in a Progress and burned up on re-entry
Displays	The EMU is equipped with Caution and Warning Software (CWS) which sends messages to the Display and Control Module (DCM) mounted to the front of the suit and warning tones to the crewmember's Comm Cap. The crewmember views messages and suit parameters on a 12-character LCD on the DCM.	The Orlan suit is equipped with Caution and Warning (C&W) lights on the front of the suit and in the helmet which alerts the crewmember when critical suit parameters are beyond acceptable values
Communication	The EMU radio uses an Ultra High Frequency (UHF), duplex communication system. (Hardline communication is used for IV operations in the airlock.) EV crewmembers talk to the IV crewmember or the Capcom on the ground	The Orlan radio uses an UHF, duplex communication system. EV crewmembers talk directly with engineers on the ground (as opposed Capcom)

Table 10-2. EMU and Orlan-M comparison (continued)

Suit feature	EMU	ORLAN-M
Suit Servicing	The EMU umbilical provides power, battery recharge, suit cooling water, oxygen recharge, water recharge, and hardline communication for IV operations	The Orlan umbilical provides power, suit cooling water and prebreathe oxygen to the suit
On-orbit Maintenance	There is very little on-orbit maintenance required for the EMU because the water tanks, oxygen tanks, and battery can be recharged through the EMU umbilical. Some on-orbit maintenance would include changing out the Metox canisters (the Carbon Dioxide (CO_2) scrubbing mechanism in the suit) and resizing the EMU with various sizing rings	There is a relatively large amount of on-orbit maintenance required for the Orlans because the water tanks and oxygen tanks are completely replaced after each EVA (as opposed to being resupplied via an umbilical)
EVA Training	Task-based: U.S. EVA training currently utilizes a task-based training program. crewmembers are trained to perform very specific tasks for an EVA on a specific flight. (For example: Task-based training teaches the crewmember to use a specific power tool on a specific bolt, using a particular torque setting and turning it a set number of times.) Although task-based training has been effective in the shuttle program, the ISS EVA training will become more skills-based in the future	Skills-based: Russian training utilizes a skills-based training program. Skills-based training teaches general concepts and generic skills which apply to numerous tasks and a variety of EVAs. (For example: Skills-based training would teach the crewmember general concepts about a power tool, how to use it, what its capabilities are, and when it should be used. Skills-based training does not necessarily go into the details of flight specific tasks.)

10.4 ISS Joint Airlock

The ISS Joint Airlock, scheduled to arrive on Flight 7A and illustrated in Figure 10-3, provides access to the vacuum of space for EVA capability. Nominally, two full EMUs and a short EMU (an EMU without the Lower Torso Assembly) are stowed in the Joint Airlock. In addition, two Orlans may be stowed in the Equipment Lock in the event of an Orlan-based EVA. ***The Joint Airlock is the prime site for EMU-based EVAs and is capable of supporting Orlan-based EVAs. It is connected to the starboard side of Node 1 by the Space Station Remote Manipulator System (SSRMS), also known as the Space Station robot arm. The two distinctive components of the Joint Airlock are the Equipment Lock and the Crew Lock.***

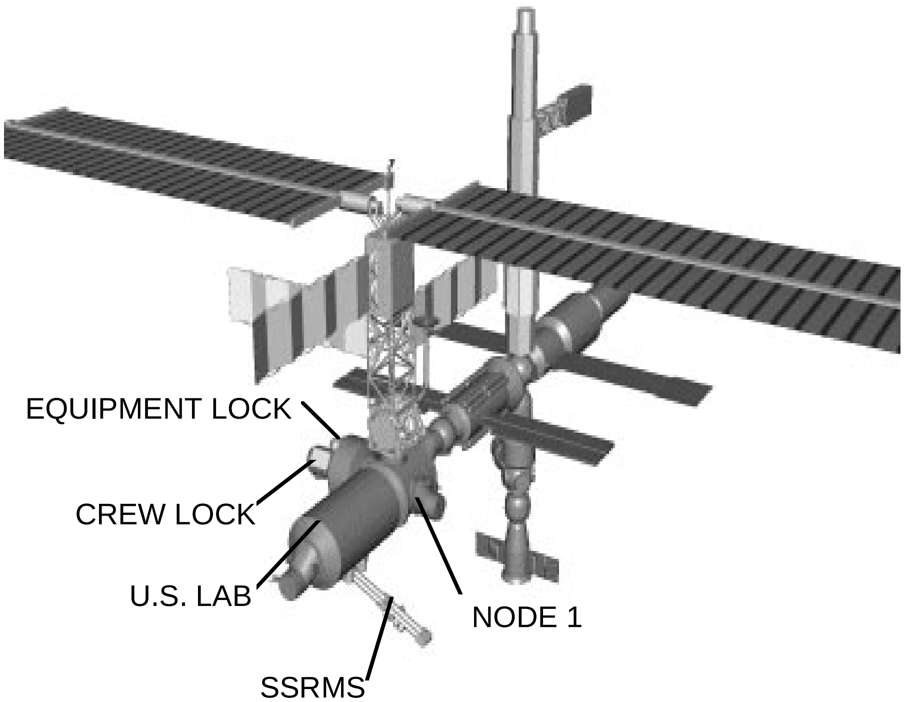

Figure 10-3. ISS at 8A

10.4.1 Components of the Joint Airlock

The ISS Joint Airlock is comprised of the Crew Lock (C/L) and the Equipment Lock (E/L) (Figure 10-4). Together they provide the capability to service, maintain, don/doff, and store EMU and Orlan spacesuits.

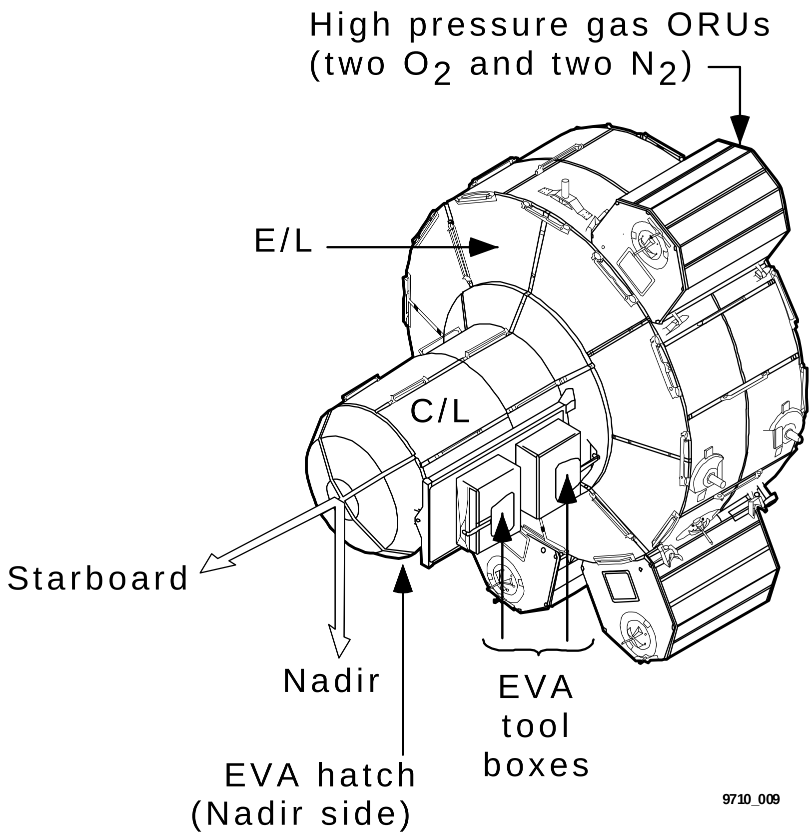

Figure 10-4. Crew lock and equipment lock

Crew Lock: ***The C/L (Figure 10-5) is the portion of the airlock that will nominally be depressed to vacuum so the crew can go EVA.*** Its design was derived from the shuttle external airlock (rotated 90°). It provides the egress point to vacuum via the EVA hatch. As the C/L is depressed down to 3 psi, the Depress Pump in the airlock is used to reclaim 70-80 percent of the cabin atmosphere. The rest of the atmosphere (3 psi down to vacuum) is vented to space through the Manual Pressure Equalization Valve (MPEV) on the EVA hatch. There are also MPEVs located on the IV hatch and the Node 1 starboard hatch.

The Umbilical Interface Assembly (UIA) panel is located on the wall of the C/L and supplies consumables to the spacesuits via an umbilical. In between a series of EVAs, EMUs may be stored in the C/L.

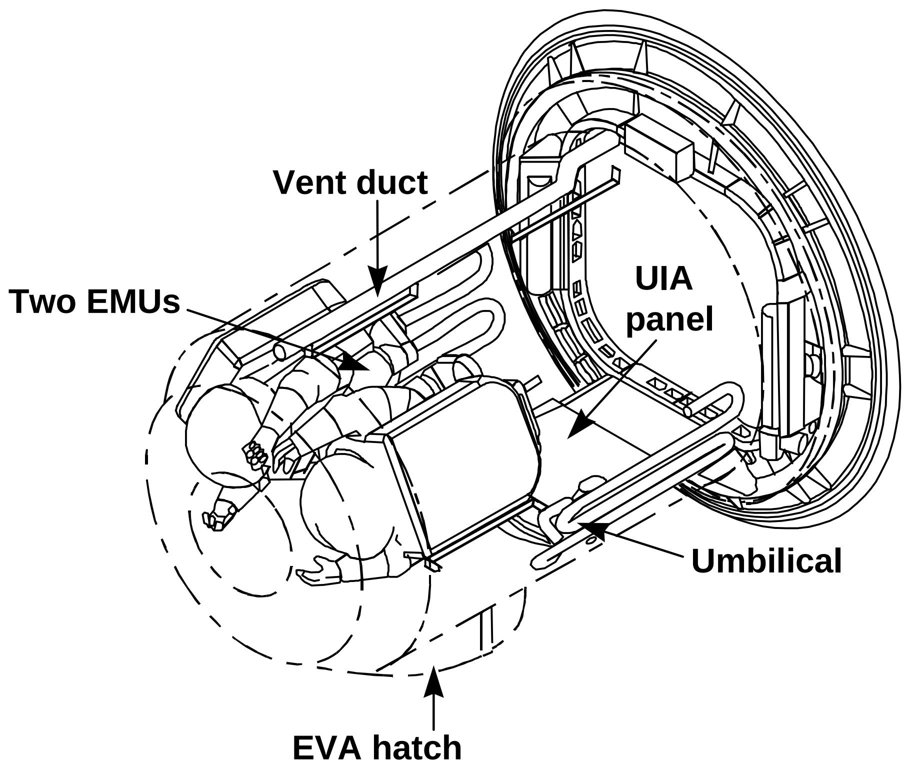

Figure 10-5. Crew lock

Equipment Lock: ***The E/L (Figure 10-6) is used for stowage, campout (when the crewmembers must sleep in the airlock overnight before an EVA), recharge/servicing of EMUs and Orlans, and donning/doffing of EMUs and Orlans.*** The majority of the EMU EVA equipment is stored in the E/L, including EMU ancillary equipment, SAFERs, batteries, power tools, and other important supplies. Attached to the seat tracks of the E/L are EMU Don/Doff Assembly (EDDA) stations that facilitate EMU mounting and servicing. In the event of an Orlan-based EVA out of the Joint Airlock, the Orlan Don/Doff Assemblies will also mount to the EDDA seat tracks in the E/L to allow for Orlan donning/doffing and servicing.

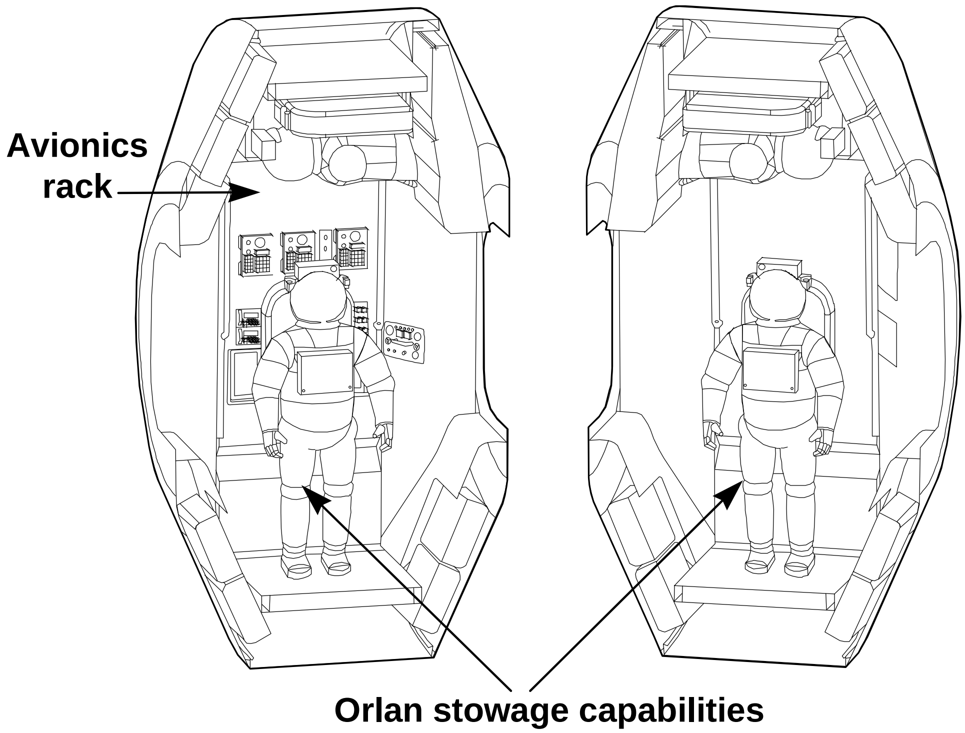

Figure 10-6. Equipment lock

10.4.2 ISS Joint Airlock System Interfaces

The Joint Airlock contains many system interfaces, known as Service Performance and Checkout Equipment (SPCE), that are essential for EMU servicing. The following are overview definitions of the SPCE items located in the E/L and C/L:

Power Supply Assembly (PSA) - The PSA receives 120 V dc from the Station power from RPCM AL-2A3B-C (A054) and converts the power to 18.5 V dc for the EMU and 28 V dc for the Orlan depending on the switch configuration. The PSA also has an auxiliary port (28 V dc) to power portable equipment.

Battery Charger Assembly (BCA) - The BCA has four separate charger units. Each charger has six different channels capable of charging a variety of batteries including power tool batteries, helmet light batteries, and EMU batteries. The BCA is reprogrammable from a serial data port to accommodate any type of battery.

Battery Stowage Assembly (BSA) - The BSA stores the batteries to be recharged and contains a unique connector for each type of battery. The capacity of the BSA is 16 batteries. There is an external port that can accommodate six more batteries if needed.

EMU Don/Doff Assembly (EDDA) - The EDDA is used for suit donning/doffing, storage, and servicing. It is hinged to allow access to the PLSS for servicing tasks as well as access to the rack behind it.

EMU Water Recharge Bag - The EMU Water Recharge Bag is a portable water storage unit that is filled from the galley for EMU water recharge. One bag holds 20 lbs of water which is enough water to recharge two EMUs.

In-flight Refill Unit (IRU) - The IRU pumps the water from the EMU water recharge bag to the EMUs for water recharge via the UIA panel (umbilical). The IRU has an inlet for the EMU water recharge bag and an auxiliary port for additional water supply. The auxiliary port can be used to fill the EMU drink bags.

Umbilical Interface Assembly (UIA) - The UIA is the major consumables interface in the Joint Airlock. It provides servicing through the umbilicals. For the EMUs, the UIA supplies water for recharge, suit cooling, waste water return, O_2 supply, hard-line communication, and suit power. Located on the UIA panel is the Onboard Spacesuit Control Assembly (OSCA) which provides prebreathe O_2 to Orlans at 70 pounds per square inch gauge (psig). The UIA panel in the C/L supports servicing of two EMUs, two Orlans, or one of each simultaneously.

SPCE Maintenance Kit - The SPCE maintenance kit is comprised of the equipment required for SPCE maintenance and miscellaneous items. It includes an umbilical purge tool, a cooling loop flushing fixture, additional EMU water recharge bags, filters, an EMU serial data cable for EMU diagnostics, and critical backup units. These items might not be stowed together but are collectively referred to as the SPCE maintenance kit. Figure 10-7 shows the Joint Airlock system interfaces.

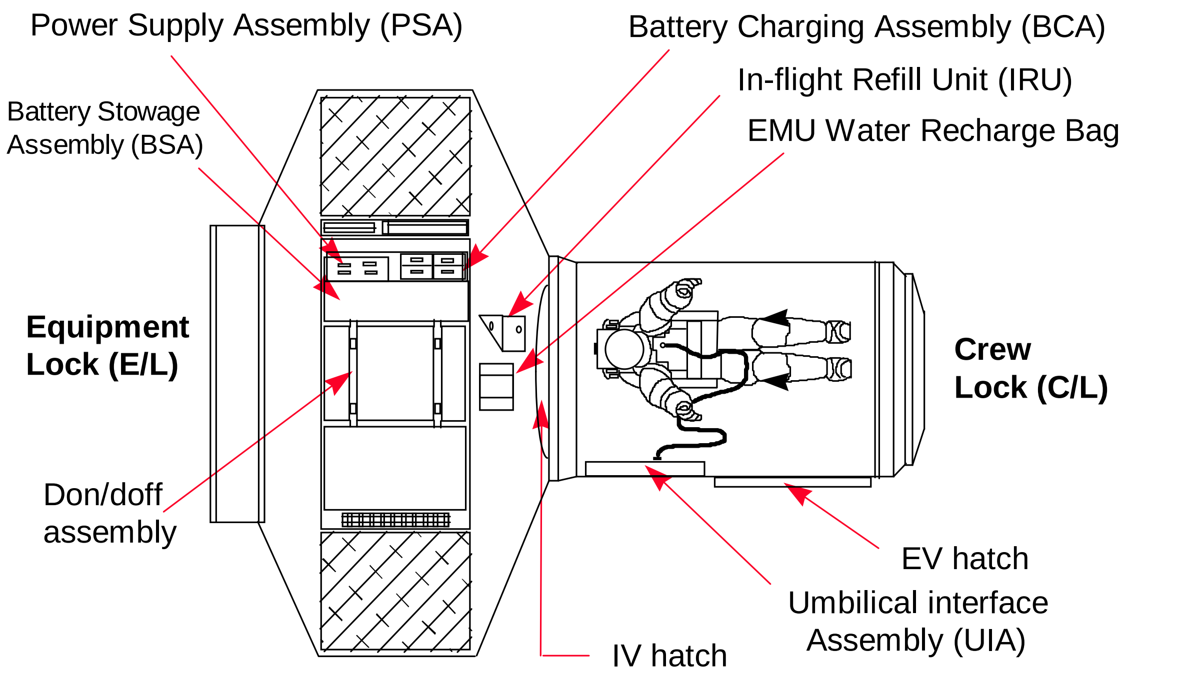

Figure 10-7. Joint airlock system interfaces

10.5 EVA Operations

There are numerous operations that must occur before and after an EVA to ensure a successful EVA. These activities include preparing the airlock, inspecting the suits, prebreathe protocol procedures which guard against decompression sickness, servicing the suit after an EVA, and closing out the airlock.

10.5.1 Prep/Post Activities

There are many procedures which must be accomplished before and after an EVA. The activities which occur before an EVA are called "Prep" (as in *prep*aration) activities. The activities that occur after an EVA are called "Post" activities. Table 10-3 defines the most common Prep/Post activities required to support U.S. EVAs.

Table 10-3. Prep/Post EVA procedures

Before an EVA:	After an EVA:
Airlock Prep This is performed the day before EVA or the day before the orbiter docks to the Station. The purpose is to configure and activate the airlock	**Repress** EV crew ingresses and connects to the umbilicals. The IV hatch MPEV is opened to equalize C/L with E/L. Before the airlock is completely repressed, an airlock pressure integrity check occurs at 5 psi
EMU Checkout These procedures are performed at least 1 day before the EVA. (In a series of EVAs, EMU Checkout would be performed approximately every five EVAs.) The purpose of EMU Checkout is to ensure the integrity of the suits **Campout** Campout (so named because the crew sleeps in the airlock overnight) is a part of the EMU prebreathe protocol to prevent decompression sickness. It is performed the night before an EVA and includes a 1 hr initial mask prebreathe on 100% O2, depress of joint A/L to 10.2 overnight, pre-sleep, sleep, post-sleep, repress of A/L to 14.7 for personal hygiene break while on portable O_2 masks, and depress of A/L back to 10.2. During this time, two crewmembers are isolated in the airlock overnight **EVA Prep** This is performed the day of an EVA and includes preparation activities, suit donning, N_2 purge at 14.7, and a final 30-minute, in-suit prebreathe **Depress** EV crew depresses C/L to 3 psi via the depress pump, stopping at 5 psi for a leak check of the EMU. The final depress to vacuum is accomplished by venting the remaining atmosphere through the EVA hatch MPEV	**Post EVA** This is performed directly after repress. EV crew doffs suits at the EDDAs, stows EMU ancillary equipment, performs suit drying and seal maintenance, performs battery, and METOX recharge **EMU Servicing** This is performed the day after an EVA. Crew verifies that batteries, METOX, and O_2 are recharged, and performs EMU water recharge **Airlock Close-out** This is performed after the last EVA of a series of EVAs to configure the airlock to a dormant mode until the next scheduled EVA. Airlock equipment is powered down and the racks are secured

10.5.2 Decompression Sickness Prevention

In order to prevent decompression sickness (also known as the bends), crewmembers must eliminate the nitrogen in their bloodstream. A prebreathe protocol has been established in both the Russian EVA training and the U.S. EVA training which outlines steps to do so. The Russian prebreathe protocol consists of breathing 100 percent O_2 for 30 minutes while in the suit. The U.S. prebreathe protocol is more complicated. The operational goal of the prebreathe protocol is to spend as little time as possible in the final in-suit prebreathe, or on Quick Don Masks (QDMs) for the initial prebreathe, without compromising the standard of decompression sickness prevention. (QDMs are uncomfortable and inconvenient. The in-suit prebreathe is tiring and cuts into the amount of time a crewmember can perform EVA tasks.) The following chart outlines the prebreathe protocol for an EMU-based EVA, assuming a suit pressure of 4.3 psid during the EVA.

Time at 10.2 psi	Initial prebreathe	Final in-suit prebreathe
0 hours	0 minutes	4 hours
12 hours	60 minutes	75 minutes
24 hours	60 minutes	40 minutes
36 hours	0 minutes	40 minutes

This protocol indicates that if the cabin pressure has been at 10.2 psi for at least 36 hours, then the crewmember has only one final prebreathe with 100 percent O_2 in the suit for 40 minutes. At the other extreme of the chart, if the cabin has remained at 14.7 the entire time (zero hours at 10.2), then a 4-hour in-suit prebreathe is required. In the shuttle program, it is reasonable to depress the entire cabin down to 10.2 for a period of time to shorten the length of the final, in-suit prebreathe. However, in the ISS program, it is unreasonable to depress the entire Station down to 10.2 every time an EVA is scheduled. As a result of this predicament, the Campout Prebreathe protocol was developed in an effort to avoid long in-suit prebreathe times.

Campout begins the day before the EVA. Initially, crewmembers must wear prebreathe masks (QDMs) in order to breathe 100 percent O_2 for 1 hour before their sleep period. Next, the Joint Airlock (both the E/L and the C/L) is depressed down to 10.2, and the two EV crewmembers sleep in the airlock overnight. After the sleep period is over (at least 8 hours), the Joint Airlock is repressed back to 14.7 and the EV crewmembers must don the QDMs again for an additional hour during their hygiene break and postsleep activities. Finally, the airlock is depressed back down to 10.2, where the crew begins EVA preparation activities. As a result of the Campout protocol, the EV crewmembers only have a 30-minute, in-suit prebreathe just prior to depress to vacuum, before their EVA.

10.6 EVA Tools and Restraints

There are over 600 EVA tasks planned for the assembly of the ISS. Although this may sound overwhelming, in reality, most of these tasks may be simplified to bolts and connectors. Station EVAs consist mostly of loosening launch restraints, installing handrails, connecting and assembling structures (such as antennas and pieces of truss). In addition, there are tasks which involve setting up connectors for umbilicals which provide power, data and fluids to the Station. In general, the SSRMS/RMS (Shuttle Remote Manipulator System) docks modules together, and EVAs ensure that all the proper connections have been made. Most of these tasks are hand and labor intensive. There are numerous tools and restraints which are used to accomplish these EVAs. The rest of this section is dedicated to providing a picture and a very brief description of these ISS tools and crew restraints.

10.6.1 Mini-Workstation

The Mini-Workstation (MWS), illustrated in Figure 10-8, attaches to the front of the EMU around the DCM. It can be used to carry small tools and provides a loose crew restraint with the end effector and retractable tether. In other words, the loose restraint helps the crewmembers stay at their worksite; however, they have to use a hand for stability when tightening bolts or performing other such tasks. The MWS is manifested on all flights.

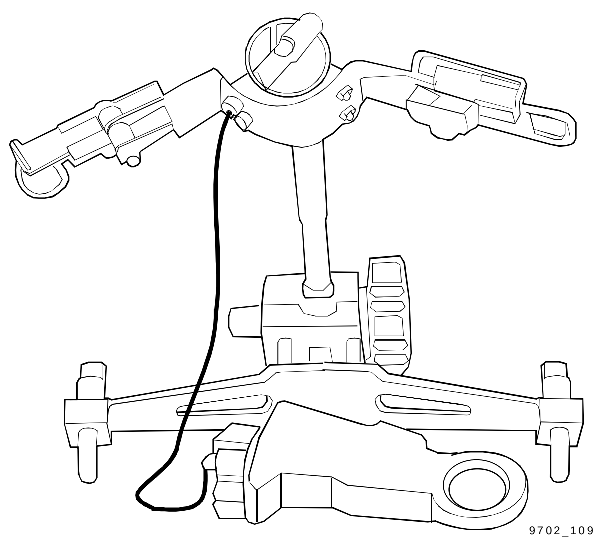

Figure 10-8. Mini-Workstation

10.6.2 Multi-Use Tether

The Multi-Use Tether (MUT) is attached to the MWS and can carry 75-100 lb. Referenced in Figure 10-9, it can also be used to transport small objects such as Orbital Replaceable Units (ORUs) and Articulating Portable Foot Restraints (APFRs). The MUT end effector provides a semi-rigid restraint for EV crewmembers at the worksite by clamping onto a handrail. Advantages of the MUT are that it requires less time to set up than APFRs and is more stable than the MWS end effector. The MUT is a part of the standard tool complement starting on Flight 2A.

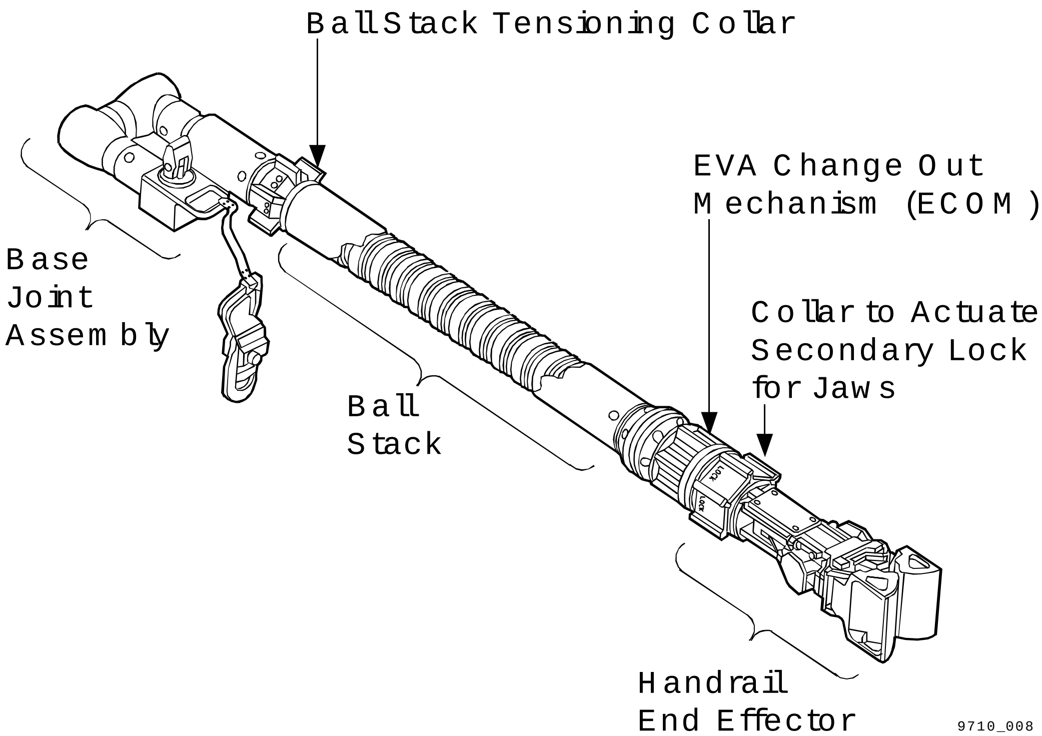

Figure 10-9. Multi-Use Tether

10.6.3 Portable Work Platform

The Portable Work Platform (PWP), illustrated in Figure 10-10, is composed of three modular components:

a. the APFR

b. the Temporary Equipment Restraint Aid (TERA)

c. the Tool Stanchion

It is used in a variety of configurations, according to the EVA tasks which are to be performed.

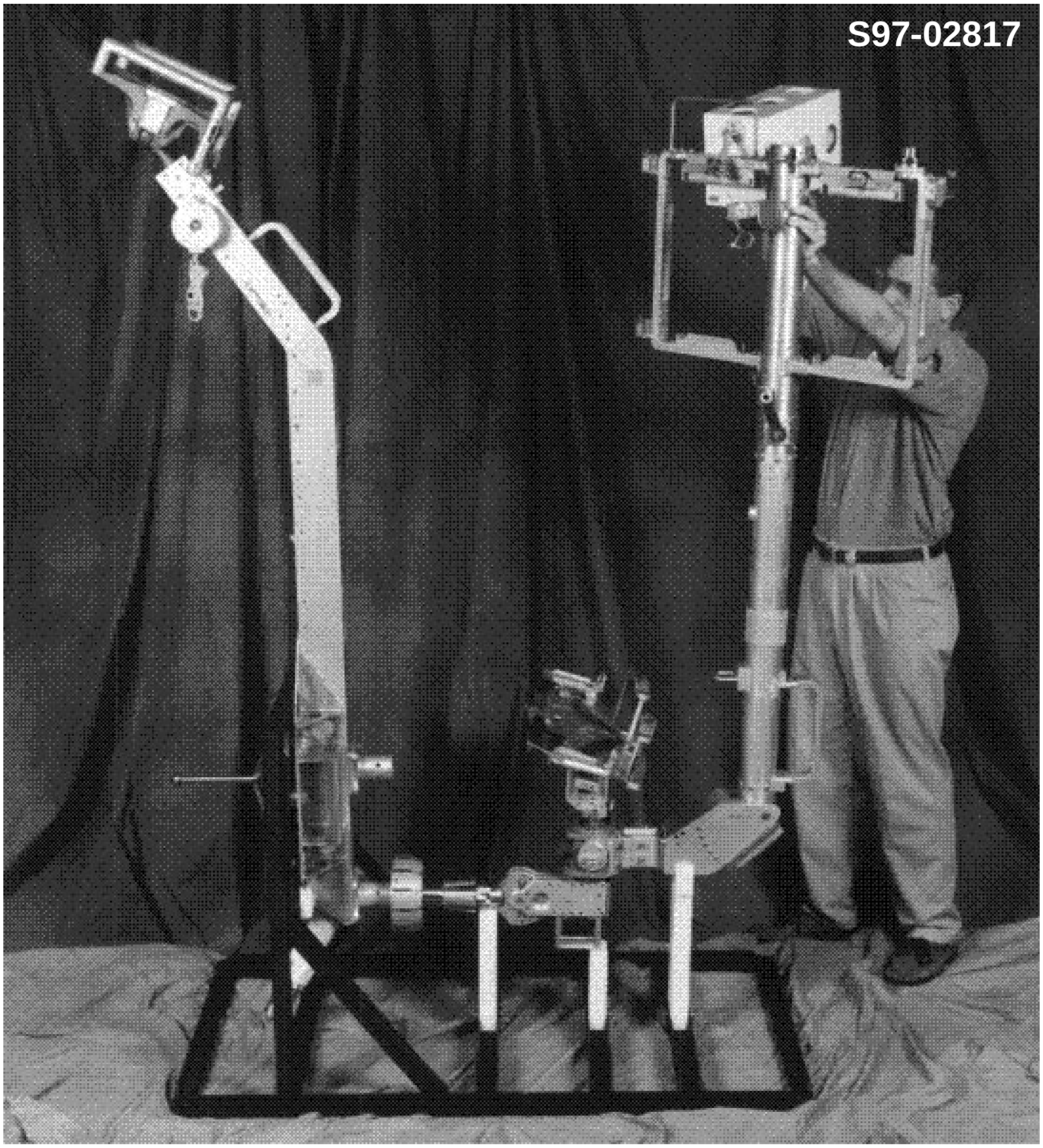

Figure 10-10. Portable Work Platform

10.6.3.1 *Articulating Portable Foot Restraint*

The Articulating Portable Foot Restraint (APFR) attaches directly to the ISS, the SSRMS/RMS or the TERA via a socket (see Figure 10-11). It provides the crewmember with rigid restraint at the worksite and a load limiter protects the structures that it is mounted in. There are foot pedals for moving the APFR in the yaw and roll directions. The joint articulation in the pitch direction must be adjusted prior to ingressing the APFR.

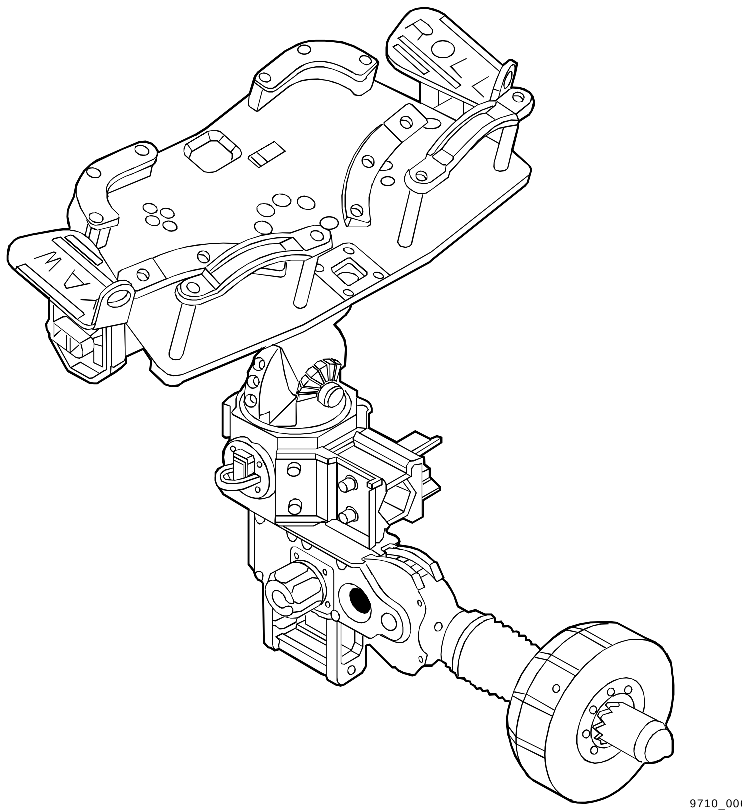

Figure 10-11. Articulating Portable Foot Restraint

10.6.3.2 *Temporary Equipment Restraint Aid*

The Temporary Equipment Restraint Aid (TERA), illustrated in Figure 10-12, interfaces to the SSRMS/RMS via a grapple fixture. It is a support structure that provides a grid for holding replacement ORUs and other miscellaneous EVA equipment. The ORU adapter plate interface is an articulating mechanism which allows the restrained crewmember to move the ORU to a convenient position.

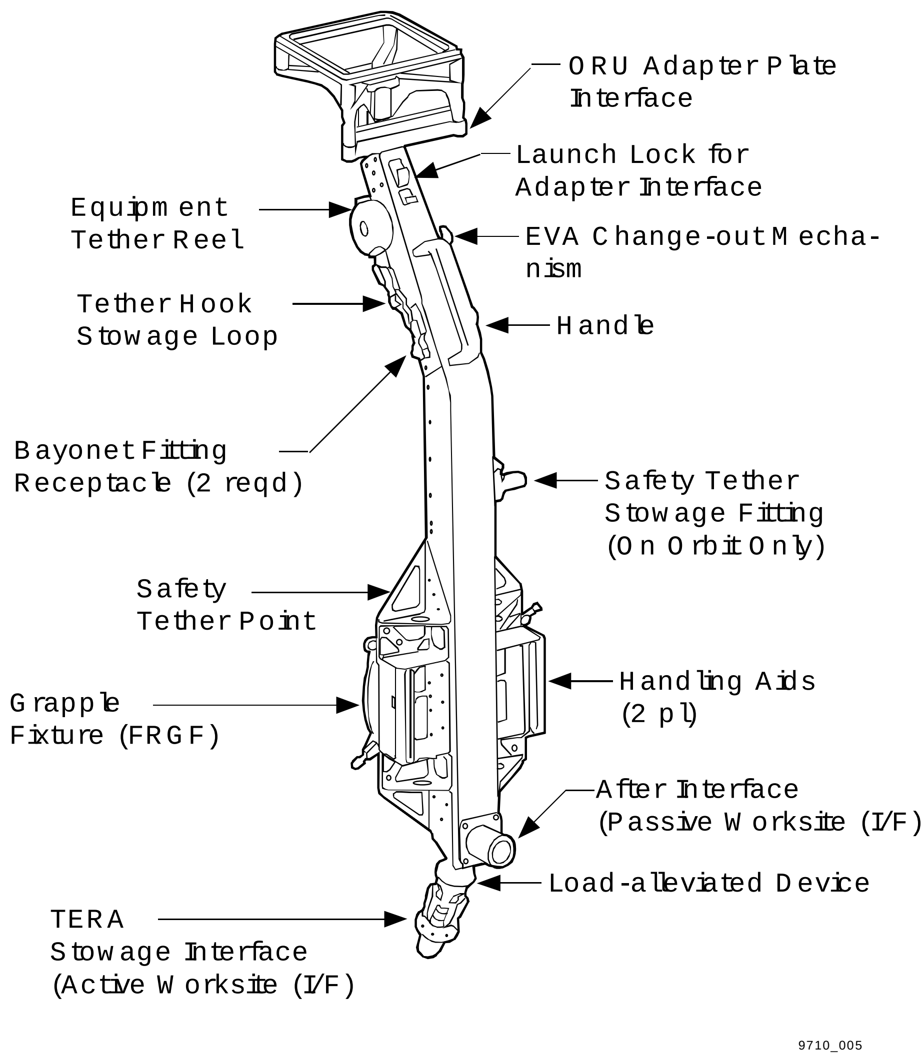

Figure 10-12. Temporary Equipment Restraint Aid

10.6.3.3 *Tool Stanchion*

The Tool Stanchion attaches to the APFR (see Figure 10-13). Tool boards slide into the top of the stanchion. It functions much like a workbench, holding tools and providing temporary stowage of old ORUs. The crewmember is able to yaw and tilt the tool stanchion with respect to the APFR.

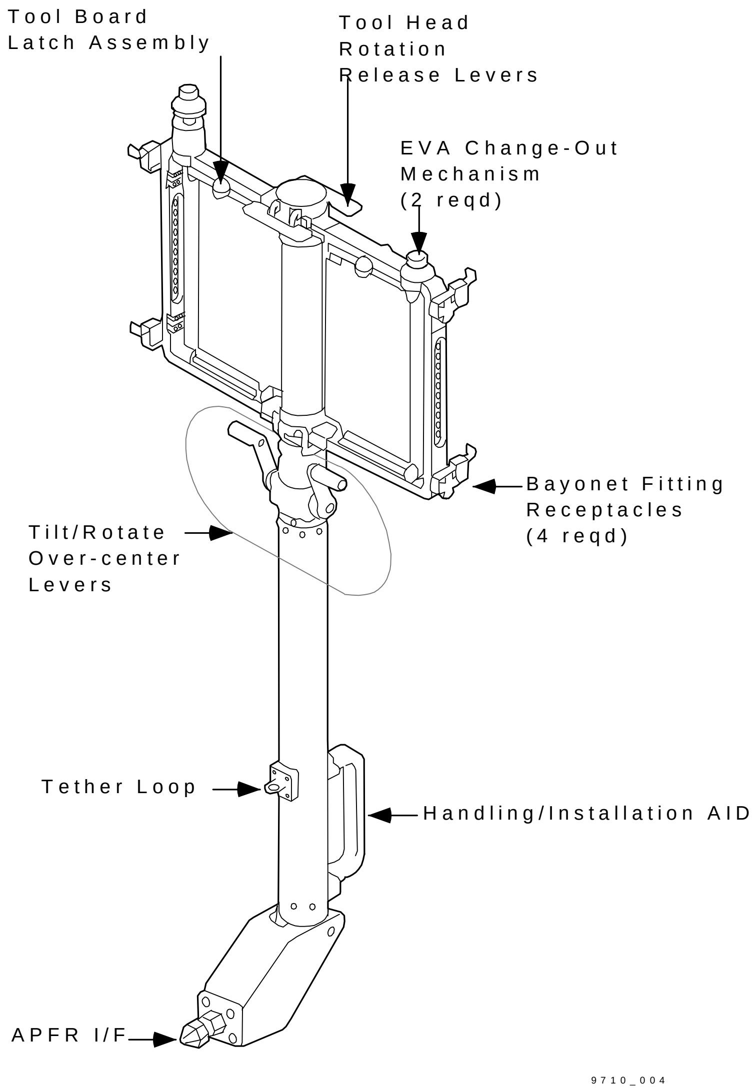

Figure 10-13. Tool stanchion

10.6.4 *Crew and Equipment Translation Aid Cart*

The Crew and Equipment Translation Aid (CETA) cart can efficiently and effectively translate EV crewmembers, EVA equipment and tools, and ORUs. Illustrated in Figure 10-14, it is manually operated by an EV crewmember who utilizes a hand brake to stop and secure the cart at a worksite. The CETA cart translates along the Mobile Transporter (MT) rails and can be used as a work platform to access various worksites on ISS. There will eventually be two CETA carts permanently on Station: one is manifested on Flight 9A and one on 11A.

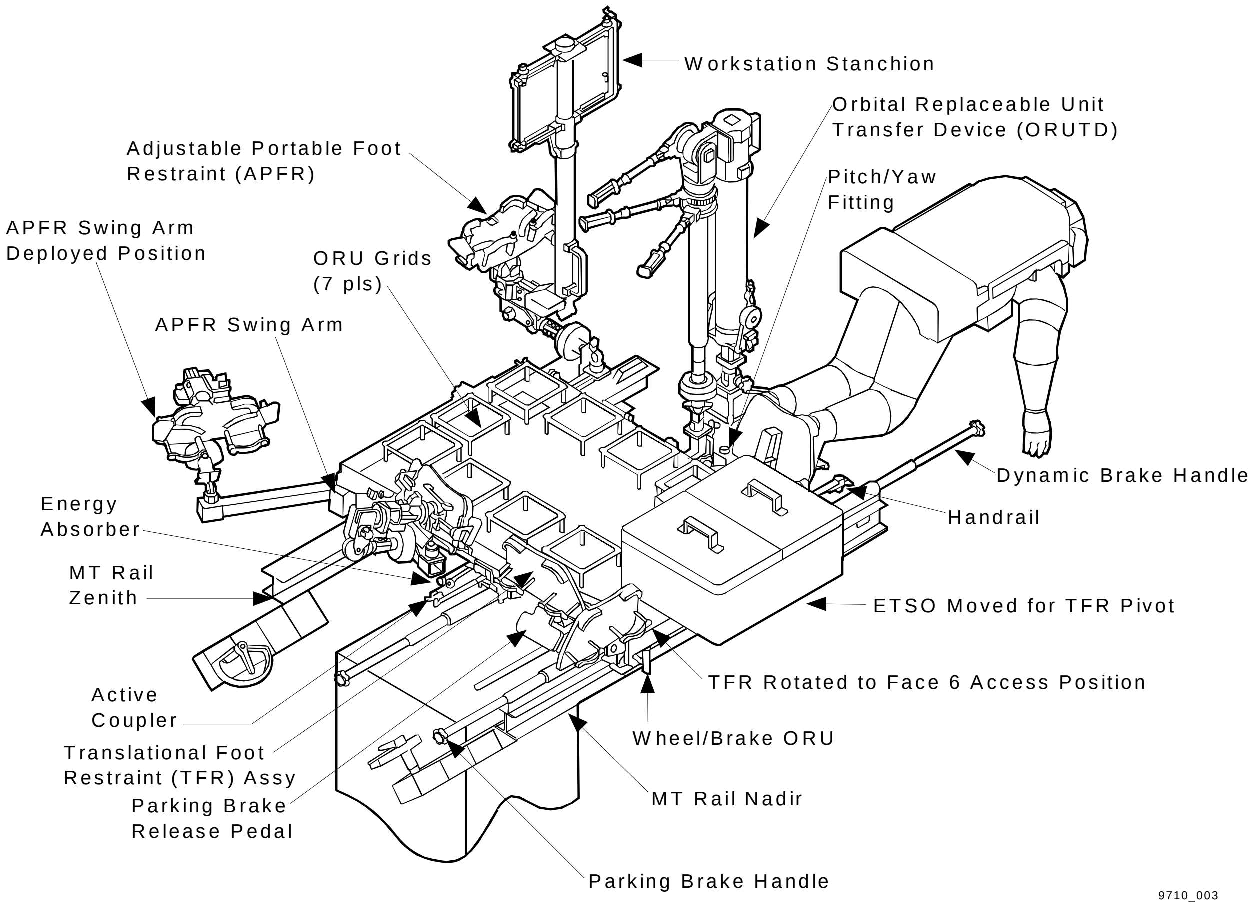

Figure 10-14. Crew and Equipment Translation Aid Cart

10.6.5 *ORU Transfer Device (Crane)*

Shown in Figure 10-15, the Crane is a mechanical device that facilitates the transfer of ORUs to and from worksites along the Truss structure during maintenance EVAs. The Crane has a telescoping boom which extends to 18 feet and possesses pitch and yaw capabilities. It may be operated manually (with the crank) or with a power tool and is stowed on the CETA cart. Currently, there is a Crane manifested on Flights UF-1 and 7A.

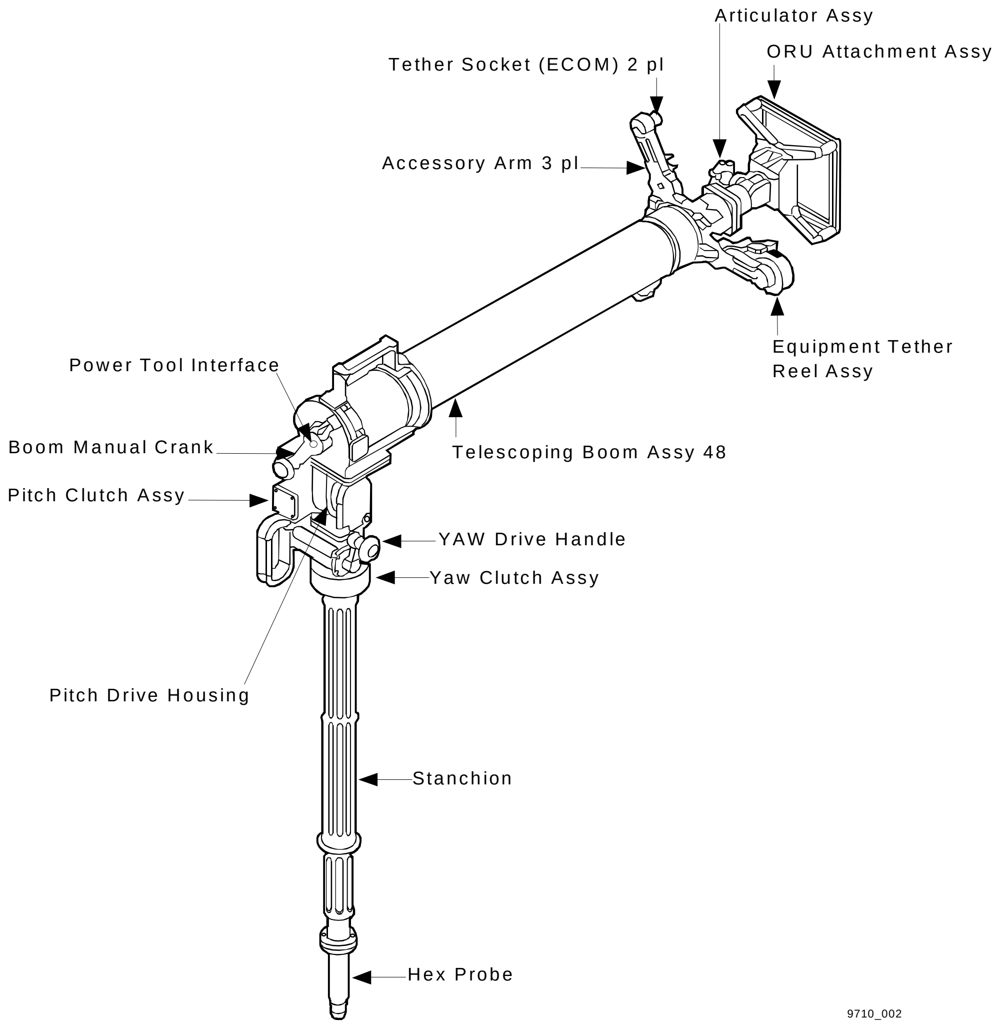

Figure 10-15. ORU transfer device (Crane)

10.6.6 *Pistol Grip Tool (Power Tool)*

The power tool (Figure 10-16) is a self-contained, computer-controlled, battery-powered, pistol-grip style tool. It may also be used as a non-powered ratchet wrench. It is comparable to a very smart electric drill. Its function is to apply torque to mechanical interfaces and fasteners (such as bolts) and may be used with various socket extensions and torque multipliers. Torque, speed, and turn limits may be programmed into the power tool to perform many EVA tasks. The batteries which supply power to the tool are replaceable on the ground or on orbit. Each ISS flight, beginning with Flight 2A, will have two power tools to use for EVA operations.

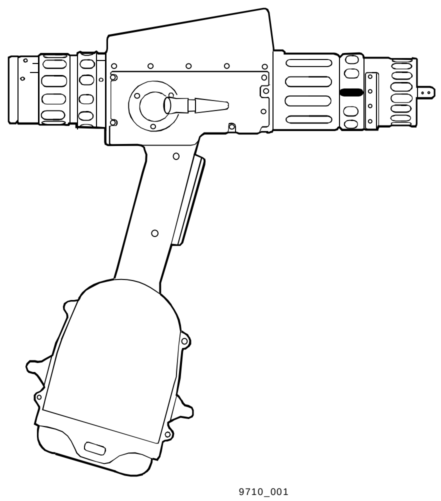

Figure 10-16. Pistol grip tool (power tool)

10.6.7 Tool Box

The Tool Box, shown in Figure 10-17, stores a variety of EVA tools. The two tool boxes on the CETA cart are used for frequently used EVA tools, while the two tool boxes on the airlock are used to stow infrequently used tools.

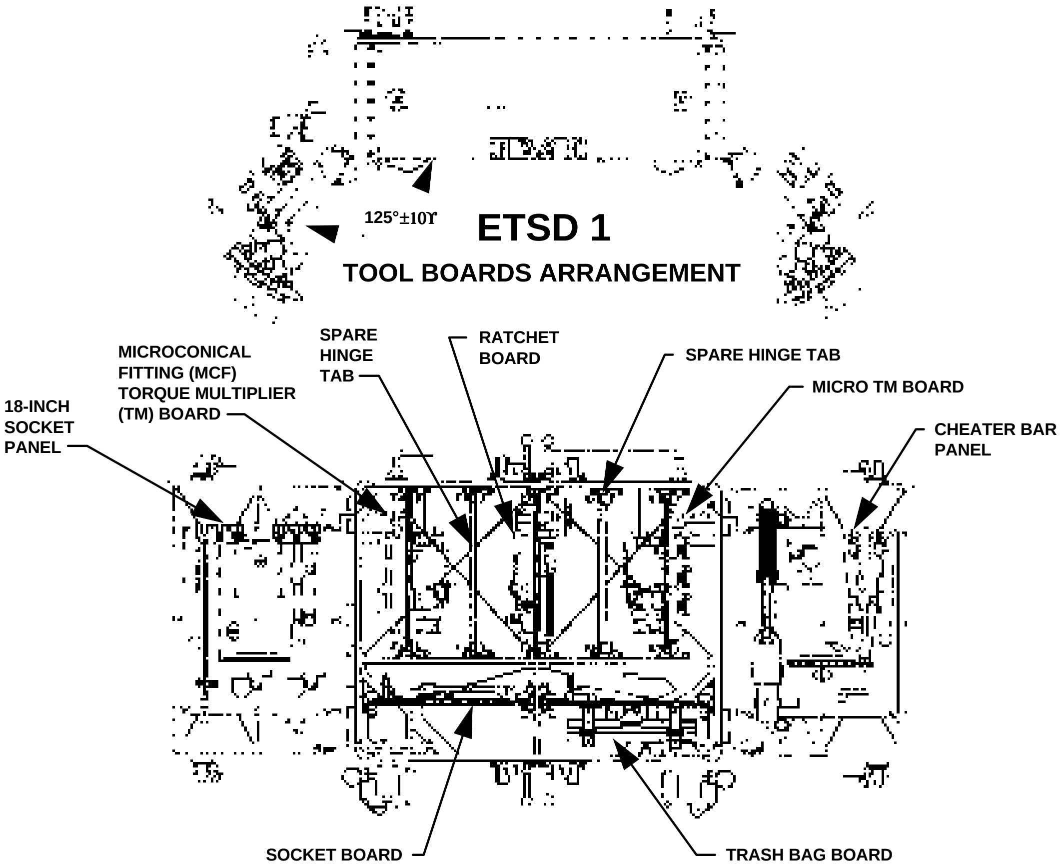

Figure 10-17. Tool box

10.7 Summary

EVA plays a major role in the assembly and maintenance of the ISS. On the Station, there are two main types of EVAs: Scheduled and Contingency. The Flight Rules define these EVAs to provide a basis by which flight controllers may make important planning decisions.

A ISS EV crewmember may be in an Orlan suit or an EMU. Although the suits serve the same purpose (to provide life support for EV crewmembers) there are many differences between the two suits which are outlined in this lesson. Some of the major differences include differences in pressure, sizing, useful life, entry method, prebreathe protocol, and displays.

The Joint Airlock, which arrives on Flight 7A, is made up of the C/L and the E/L. The E/L provides storage, and recharge/servicing for EMUs and Orlans. It also serves as sleeping quarters for the crew during the Campout phase of the prebreathe protocol. The E/L has the capability to support both Orlan-based and EMU-based EVAs. The C/L is the volume of the Joint Airlock that will nominally be depressed to vacuum so that the crew may egress the airlock for an EVA. The C/L is also the location for the UIA panel which provides multiple consumables via an umbilical to the suits.

Once the crew has egressed the airlock, there are multiple tools and restraints that are used to promote successful EVAs. The most common ISS tools/restraints are the MWS, MUT, PWP, APFR, TERA, Tool Stanchion, CETA cart, Crane, Power Tool, and Tool Boxes.

Questions

1. Indicate which of the following characteristics correspond to either the EMU or the ORLAN:

__	a.	Nominally pressurized to 4.3 psid	1. EMU
__	b.	Modular components	2. ORLAN
__	c.	After useful life, burns up on re-entry	
__	d.	Usually requires a dedicated IV crewmember to assist in donning	
__	e.	Suit parameters displayed on DCM	
__	f.	Nominally pressurized to 5.7 psid	

2. True or False. The Equipment Lock is included in the volume which will nominally be depressed to vacuum so the crew can go EVA.

3. True or False. The Mini-Workstation (MWS) can be used to provide loose crewmember restraint.

4. True or False. The Joint Airlock arrives on Flight 7A.

5. According to the EVA Flight Rules, the basic types of ISS EVAs are:

   a. Scheduled and Unscheduled

   b. Scheduled and Contingency

   c. Scheduled, Unscheduled, and Contingency

   d. None of the above